ALCOHOL: MECHANISM

Ethanol, the alcohol found in beverages, enters the bloodstream and readily reaches the brain. It is a central nervous system depressant, meaning it slows aspects of brain and nerve activity. Its effects involve communication between nerve cells, liver metabolism, kidney fluid regulation, and sleep. The amount consumed, drinking speed, food intake, body composition, genetics, and medications influence response.

ABSORPTION & LIVER METABOLISM

Alcohol is absorbed through the stomach and, primarily, the small intestine. Food slows stomach emptying and usually delays absorption. Once absorbed, alcohol distributes through body water. Blood alcohol concentration, or BAC, measures alcohol in the bloodstream; a BAC of 0.08% means 0.08 grams per deciliter of blood. BAC can continue rising after drinking stops because absorption may still be occurring. The liver breaks down most alcohol. The enzyme alcohol dehydrogenase converts ethanol into acetaldehyde, a toxic compound that can damage cells. Aldehyde dehydrogenase then converts acetaldehyde into acetate, which other tissues can use for energy and ultimately break down into carbon dioxide and water. These processes have limited capacity, so alcohol accumulates when absorption outpaces clearance. Genetic differences in these enzymes help explain differences in flushing and other reactions.

BRAIN SIGNALING, COORDINATION, & JUDGMENT

Alcohol enhances some effects of GABA, the brain's main inhibitory messenger, while suppressing aspects of glutamate, its main excitatory messenger. This shifts communication toward reduced activity, contributing to relaxation, sedation, slower reactions, and impaired memory formation. Disruption of the cerebellum, which coordinates movement, contributes to poor balance and coordination. Effects on the prefrontal cortex weaken judgment and impulse control, sometimes producing apparent stimulation or sociability despite alcohol's depressant action.
Alcohol also increases dopamine signaling in reward pathways. Dopamine helps the brain learn which experiences to repeat and associate drinking with particular places, people, or emotions. High alcohol can suppress brain systems controlling breathing and consciousness.

SLEEP & FLUID BALANCE

Sleep architecture means the normal sequence of non-REM and REM sleep stages. Alcohol can initially cause sleepiness, but it delays and reduces REM sleep, a stage involved in memory and emotional processing. As alcohol levels fall, sleep may become fragmented, with more awakenings. Sedation therefore does not necessarily mean restorative sleep. Alcohol also suppresses vasopressin, a hormone that helps the kidneys conserve water. Increased urination can contribute to dehydration. However, dehydration alone does not explain a hangover; disrupted sleep, inflammation, stomach irritation, and alcohol's metabolic byproducts also contribute.

REPEATED EXPOSURE, TOLERANCE, & DEPENDENCE

With repeated heavy exposure, the brain adapts to alcohol's inhibitory effects. Tolerance means a reduced response to the same amount; it does not eliminate impairment or organ damage. Physical dependence means these adaptations can produce withdrawal when alcohol levels fall, including tremor, anxiety, insomnia, and potentially life-threatening seizures. Repeated heavy exposure can also damage the liver, pancreas, heart, and nervous system. Alcohol consumption increases the risk of several cancers.

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